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XV. *Account of the Earthquake felt in various Parts of England, November 18, 1795; with some Observations thereon.* By Edward Whitaker Gray, M. D. F. R. S.

Read May 12, 1796.

HAVING been desired by the President of the Royal Society to draw up, from various letters transmitted to him and to the Society, and from such other authentic information as I might be able to procure, an account of the earthquake which was felt in most of the midland counties of England, on Wednesday, November 18, 1795, I beg leave to lay before the Society the following account thereof; which, however imperfect it may be, contains all the material information I have been able to obtain upon the subject.

The earthquake happened, as is already said, on Wednesday, November 18, about eleven o'clock at night. The state of the weather, and other circumstances previous to it, are described in some of the letters hereafter noticed. Before I proceed to take notice of them, I shall endeavour to give a general idea of its extent.

It appears that the shock was felt as far to the north as Leeds, and as far to the south as Bristol. To the east it was felt as far as Norwich, and to the west as far as Liverpool. Its extent from north to south, therefore, was about 165 miles;

and its extent from east to west about 175. In this latter direction, or rather from north-east to south-west, it may be said to have reached nearly across the island.

The counties in which I have any account of the earthquake having been perceived are Somersetshire, Wiltshire, Oxfordshire, Buckinghamshire, Northamptonshire, Huntingdonshire, Norfolk, Lincolnshire, Leicestershire, Warwickshire, Gloucestershire, Herefordshire, Worcestershire, Staffordshire, Cheshire, Derbyshire, Nottinghamshire, Yorkshire, and Lancashire.

To those counties may, I think, be safely added Rutlandshire, Berkshire, Bedfordshire, Cambridgeshire, and Shropshire. I have not indeed met with any account of the earthquake from either of them; but, whoever will examine the situation of these counties, with respect to those above enumerated, will find it difficult to conceive that they were not, in some degree, affected by it.”*

Perhaps a general idea of the extent of the earthquake cannot be better obtained, than by supposing the four places already mentioned as its extreme points, namely, Bristol, Liverpool, Leeds, and Norwich, to be joined by right lines, so as to form a quadrangle. That quadrangle will comprise, as accurately as such a figure can be expected to do, the parts to which it may reasonably be presumed to have extended.

Respecting the effects of the earthquake in many of the counties abovementioned, I have not been able to collect any particulars which appear to me worth relating; with regard

* I know it has been said that earthquakes have been felt at two places distant from each other, and not at an intermediate place; but I see no sufficient reason for supposing that to have been the case in the present instance.

to such counties, therefore, I think it unnecessary to do any thing more than to record its having reached them. And, for such record, I have, in some instances, considered the newspapers of the respective counties, or some such public testimony, as sufficient authority; provided the situation of the place where the earthquake was said to have been felt was such as to come within the general outline of its extent.

I shall now proceed to those details respecting the earthquake which have been received from various counties; taking them in the order in which those counties are mentioned above.

From Belton, the seat of Lord BROWNLOW, in Lincolnshire, the following account was sent by Mr. CHRISTOPHER DRIFFIELD, in a letter dated November 19.

“ We had yesterday a most violent hurricane of wind, which
“ began about eight o’clock in the morning, and continued
“ till about one. After the wind settled we had a heavy rain,
“ which ceased about four in the afternoon, and it was a very
“ fine evening; but, about eleven o’clock, as near as I can say,
“ we felt a terrible shock of an earthquake, which lasted about
“ two seconds. It shook the chair in which I was sitting, beginning with a violent rumbling, or noise, as if some large
“ carriage had run against the gate-post. It went from north
“ to south. It was generally felt at Grantham, and in this
“ neighbourhood.”

The following account of its effects in Leicestershire, is given in a letter from Mr. WILLIAM KING, dated Belvoir castle, November 30.

“ The earthquake happened, as near as I can collect, about
“ 5 or 10 minutes after eleven in the evening. The wind

“ during the day had been very brisk, but towards the evening (6 o'clock) it became almost totally calm, and continued so the whole night. The shock was strong enough at the castle to waken those who were asleep. Some, though but few, thought it was an earthquake; the general opinion was that something had fallen down in the room over head; or had struck the floor underneath; or that an adjoining partition or door had received a blow. Pendulous bodies were put in motion, as well as some doors that were not shut. Instances of both these happened in the castle, and they, in some measure, confirm an opinion that the shock was undulatory. It happened at a time when few were out of doors, but some were, and they all agree that the shock was not attended with any extraordinary light; neither was there any ball of fire, nor any singular motion, in the air.

“ The Rev. Mr. PETERS, whose residence is at Knipton, a mile and a half from the castle, gives the following account. He was going to bed, but, at the instant, stood with his back against a wall; he found the whole room shake, particularly the bed curtains. As he had felt many earthquakes in Italy, he immediately knew it to be one, and was attentive to the consequences. He declares that the air was calm at the time; had no noise in it; nor did he perceive any extraordinary light. Knipton is in a low situation, and was shaken as much as the castle.”

Of its effects at Kenilworth, in Warwickshire, the following description is given by ROBERT AUGUSTUS JOHNSON, Esq. F. R. S. in a letter dated November 25.

“ The earthquake was felt at Kenilworth about twenty minutes after eleven; but our common clocks are usually kept

“ with the sun, and were therefore, at that time, nearly a
“ quarter of an hour too fast ; by true time, I reckon it to
“ have been six minutes past eleven. I had lain down some
“ little time, when I felt the bed raised up. My first idea was
“ that a large dog had got under it, but the immediate shak-
“ ing of the curtains, and of the room, convinced me this
“ could not be the case. All those who were in bed, and
“ awake at the time, describe it in the same way ; every one
“ supposing that their beds were raised up by some living
“ creature under them. It was not so universally felt by per-
“ sons who were up ; those who were engaged in conversation
“ did not, in general, perceive it ; but, of those whose attention
“ was less occupied, some felt their seats slipping from under
“ them, others saw things move which were hung up, and
“ some heard the doors and windows rattle. Many say it was
“ attended with a low rumbling noise, but this I did not hear.
“ The motion, as well as I can judge, continued nearly two
“ seconds. The evening was perfectly calm, after a most tem-
“ pestuous night and day, with the wind nearly south-west.
“ The barometer, for thirty-six hours preceding, had varied
“ very remarkably. On Tuesday morning, the 17th, it stood
“ at 30.23, but sunk gradually, during the course of that day,
“ and more rapidly in the night : to the best of my recollec-
“ tion, it was on Wednesday morning at 28.63, and that night,
“ a little before the shock was felt, at 28.8. The thermometer,
“ in a room without a fire, was about 48 or 49° the whole
“ day. I am not able to state the degree of moisture in the
“ air, (my hygrometer being broken,) but it was loaded with
“ humidity, making the passage walls and floors damp. The
“ effects of the earthquake were most sensibly felt on the tops

“ of hills, or on high ground ; but I have not heard of its
“ having done any damage in this country.”

From Worcester the following account of it was sent by
Dr. JOHNSTONE of that city, in a letter dated November
24.

“ The earthquake was chiefly felt by persons in bed, about
“ eleven o'clock, or five minutes after, who describe the sen-
“ sation to have been as if some person under the bed had
“ heaved it up. That sensation was preceded, the instant be-
“ fore, by a noise which some call rumbling, and which others
“ compare to the falling of tiles, though none fell from the
“ houses where they lived. Many persons heard the windows
“ and doors of their rooms rattle at the same time, which in-
“ creased their alarm. Thunder and lightning had been ob-
“ served some days before ; and several persons, of a delicate
“ state of health, passed the night of the 18th in a restless
“ uneasy manner, without knowing why, though very much
“ in the manner in which they used to be affected by thunder
“ and lightning.”

In Derbyshire the shock appears to have been very severe.
A description of its effects, not only upon the earth, but also
under its surface, is contained in the two following letters from
Mr. WILLIAM MILNES, of Ashover : the first is dated No-
vember 20.

“ On Wednesday night, about a quarter past eleven o'clock,
“ a severe shock of an earthquake was felt here. I felt it very
“ sensibly ; at first I heard a rumbling kind of noise, and im-
“ mediately after it appeared as if some person or persons had
“ violently forced into the room ; the bed, and every thing
“ else, shaking very much. The workmen in Gregory mine

“ were so much alarmed by the noise, and the sudden gust of
“ wind that attended it, as to leave their work ; some expect-
“ ing that the whole mass of *bunnings* above them, which
“ contains many hundred tons weight of rubbish, had given
“ way, and that they should be buried in the ruins ; others,
“ who were at work near the new shaft, supposed that the
“ curb which supports the walling had given way, and the
“ whole shaft had run in. Several chimnies were thrown
“ down, and several families left their habitations ; indeed
“ such a general alarm was never known in this neighbour-
“ hood.”

The gust of wind mentioned by Mr. MILNES being considered as a remarkable circumstance, he was desired to make some farther inquiry concerning it : in consequence of which a second letter was received from him, dated December 4, as follows.

“ I have examined all our miners separately, and, from the
“ following circumstances, I think there cannot be a doubt
“ but the wind which was felt in the mines, on the 18th of last
“ month, rushed into the shafts from the surface.

“ Those men who were at work in the pumps, which are
“ a considerable depth below the waggon gates, and have
“ no communication therewith, did not feel the wind ; but
“ heard, in the first place, a rushing rumbling kind of noise,
“ which appeared to be at a distance, and to come nearer and
“ nearer, until it seemed to pass over them, and die away.
“ Those who were in the waggon gate which has a commu-
“ nication with the engine shaft, and the new shaft, felt a
“ very strong current of wind ; which, one man says, conti-
“ nued whilst he walked about six or seven yards, and came

“ along the gate, as if it came from the new shaft ; he had no
“ light, but, as he went along the gate, the sides thereof,
“ where he laid his hands, felt as if they were going to close
“ in upon him.

“ The only one who saw any appearance of light, on that
“ evening, in this neighbourhood, (that I have been able to
“ make out,) was a person who lives with Mr. ENOCH STE-
“ VENSON, the miller, at Mill Town. He informs me that, as
“ he and another man were returning from Tideswell, he saw,
“ when he got upon a piece of high land near Moor-hall, on
“ the road to Chatsworth, an uncommon light ; and, when
“ looking towards Chesterfield, the sky appeared to be open
“ for about the length of a mile, the colour pale red, and con-
“ tinued so while he awakened his fellow servant, who was
“ asleep in the waggon, to shew him (as he described it) the
“ strangest flash of lightning that ever was seen. From his de-
“ scription, the range of it was from east to west ; and so low
“ in the horizon that, had he not been upon high ground, he
“ could not have seen it.”

From Wirksworth, in the same county, (Derbyshire,) two letters respecting the earthquake were received from the Rev. ABRAHAM BENNET, F.R.S. of which here follow extracts. The first letter is dated November 19.

“ About twenty minutes past eleven o'clock last night, the
“ shock of an earthquake was perceived in this town, and, as
“ I have been informed, at Derby, Ashover, Bakewell, Win-
“ ster, and other neighbouring villages. I happened to be in
“ bed at the time, and was awakened by a noise, which I first
“ supposed to be like the roaring of a chimney on fire, then
“ thought it was a carriage in the street, and should not have

“suspected an earthquake; but this morning I was told that
“many persons had been much alarmed, said they heard a
“noise resembling the falling of a chimney, and went out to
“examine whether that was the case. A person just arrived
“from Derby says, that a ball of fire was seen to pass over
“the town, at the time the noise was heard. Many said their
“beds shook, and that they felt something like an electrical
“shock. At Derby some bricks were thrown down from
“chimnies. The noise was also described as resembling the
“drawing of a table over a floor, with a louder explosion at
“the last.

“The wind had blown violently from the south-west all
“day, but became calm in the evening, and the sky cleared.
“At the time the earthquake happened it was remarked that
“the air became very cold; and this morning the ground was
“covered with snow; which now melts, and the wind is
“changed to the north-east.

“These circumstances seem to favour the supposition of
“earthquakes being caused by electricity; but it is only from
“a collection of numerous facts, that any rational theory can
“be formed on the subject.”

In his second letter, dated December 21, Mr. BENNET says;
“I have been at Derby, and made inquiry about the ball of
“fire said to have been seen there, but could obtain no ac-
“count of any thing more than that several persons, who hap-
“pened to be out, perceived a flash of light, which they de-
“scribed as being like an opening of the sky. I had written
“to Mr. CHATTERTON to make every inquiry he could, but he
“heard nothing more than this, besides what was observed by
“others. I wrote also to Mr. WATSON, of Bakewell, who says

“ he had been in bed about a quarter of an hour, when he was
“ astonished by a hushing rumbling noise, and was immedi-
“ ately shook in bed, by a lifting up, of first his head, and
“ then his feet, three times in about three seconds ; his bed
“ standing south and north, he thought it came from the south.
“ At an inn there the servants were frightened by the glasses
“ shaking upon a table ; some gentlemen, in another room,
“ felt nothing of it. One person at Bakewell observed a flash
“ of light like lightning ; and Mr. BUXTON's house, (at Bake-
“ well,) which stands upon a limestone rock, was shook till
“ his bell rung.

“ The Rev. Mr. PEACH, of Edensor, was shook in bed, and
“ heard a noise in his room, like the collision of two stones.

“ At Chesterfield some chimnies fell.”

The county of Nottingham, however, appears to have been that in which the earthquake was most severely felt. From that county two very circumstantial accounts of it have been received ; one of them from the Rev. EDWARD GREGORY, in a letter dated Langar, December 12, as follows.

“ I was, on the 18th of November, at Wollaton, (the seat
“ of Lord MIDDLETON,) about three miles to the west of Not-
“ tingham, where I felt the shock of the earthquake. A vio-
“ lent gale of wind, which blew from the south-west, raged
“ with uncommon fury all the morning, and brought on heavy
“ rain about noon ; the storm still continuing with unabated
“ violence. About three o'clock the wind changed to north-
“ west, and the tempest presently subsided. The clouds now
“ separated, and formed themselves, on the northern quarters of
“ the horizon, into those very large white mountainous clouds
“ which, in the summer months, generally precede a thunder

“ storm. About sunset these clouds were very much dis-
“ persed; the air became clear, felt sharp and elastic, and
“ every appearance of a frost came on in the northern parts of
“ the sky. When the company assembled in the south draw-
“ ing-room, previous to dinner, my attention was much struck
“ with the aspect of the sky in the south and south-east quar-
“ ter; in this direction, a cloud, very black and lowering, ex-
“ tended itself over this part of the hemisphere. The margin
“ of the cloud, which was nearly parallel to the horizon, was
“ fringed, to the extent of at least forty degrees, from the south
“ towards the east, and to the breadth of perhaps a degree and
“ a half, with a very bright white light, which had very much
“ the appearance of white satin. This light was shaded, to its
“ whole extent, as it were with a veil of a deep muddy purple
“ colour. The white light, seen below this gloomy purple
“ haze, and farther contrasted by the very dark surface of so
“ extensive and lowering a cloud, formed a very striking ap-
“ pearance; so much so as to induce me to call Lord MID-
“ DLETON, and others of the company, to the window, to look
“ at it, and to remark to them, that the very angry and trou-
“ bled aspect of the sky led me to apprehend we should have
“ more of the tempest in the course of the night. I will here
“ remark that it was now near five o’clock; the sun was gone
“ down too low to cast any considerable degree of light on
“ the clouds near the western horizon, much less could he il-
“ luminate any cloud so low in the south-east as this was with
“ so bright a light. The moon, indeed, was near the western
“ extremity of this cloud; but its light, even had it been a
“ full moon, (whereas it yet wanted more than twenty-four
“ hours of being in the first quarter,) was far too weak to cast

“ on the margin of the cloud so intense a light, and that to
“ so great an extent along it. For these reasons, I was fully
“ persuaded that this luminous appearance was occasioned by
“ electric light, with which I concluded the cloud to be highly
“ charged. We went down stairs to dine, and returned again
“ to this room about eight o'clock, to pass the evening; I then
“ looked again at the sky; every extraordinary appearance
“ had now vanished, the night was dark and gloomy, the air
“ quite calm and mild. At between twenty and twenty-five
“ minutes after eleven o'clock, we were all extremely sur-
“ prised and alarmed at a sudden blast, (so I should term it,
“ rather than explosion, because it had not that sharp, com-
“ pressed elastic tone I annex to the idea of an explosion,)
“ which burst out instantaneously, somewhat below the ze-
“ nith, to the west; and, as I conjectured from the direction
“ in which the sound was heard, seemed to rush through the
“ air towards the east with great velocity, and to meet with
“ considerable resistance to its motion; for it made a whiz-
“ zing noise as it passed over us. At the instant the blast
“ burst out, it was accompanied with a very loud, deep-toned,
“ hollow, sullen sound, not altogether unlike a deep groan.
“ We were all amazed at this hideous noise; some thought
“ the window of the great room (that in the centre tower over
“ the hall) had fallen in: every one of us thought some bad
“ accident must have happened to some part of the building.
“ While we were all forming our various conjectures, I, who
“ sat close to the wall, (a north wall,) leaning with my arm
“ and shoulder on the surbase, felt myself shoved from it, and
“ my chair shaken under me, with a very quick tremulous
“ motion. All the company (eight or ten) felt the same

“ sensation from the shock ; which was so forcible, that some
“ thought I had fallen from my chair on the floor, and had oc-
“ casioned the concussion they felt ; when they saw this was
“ not the case, they then imagined the servants in the dining
“ room below us, in removing the tables, had thrown down
“ one of them. When I felt the wall shake, I had no doubt it
“ was an earthquake, and I told the company so ; but that it
“ was now over, and we were all safe, and had no reason to be
“ farther alarmed. I had scarcely uttered these words, when
“ we were shaken again. This second shock was more undu-
“ latory than the first ; at this time I was standing, and felt
“ myself lifted up a little, as the shock passed along. We were
“ all now under great apprehensions, lest other and more vio-
“ lent shocks might succeed those we had already felt ; but
“ after a few minutes had elapsed, without our perceiving any
“ thing more, our alarm subsided. Such of the company as
“ had withdrawn returned to us, to inquire what could be the
“ cause of the strange noise, and the shocks which succeeded
“ it ; not being yet aware that it was an earthquake. I have
“ already mentioned the time the blast was heard ; the first
“ shock of the earthquake came on, as near as I can guess,
“ about a minute after it ; and the second shock succeeded the
“ first at the interval of twenty seconds. I went down to the
“ steward’s room, and servants’ hall, to inquire what was felt
“ of the earthquake, and whether they saw any light at the
“ time they heard the blast. They said they saw no light
“ whatever, but that the shock caused the glasses to dance
“ upon the table, in such a manner that they imagined some-
“ body was drumming under the table with their knees. I
“ then went into the garden, to look at the sky ; it continued

“ much as it was at eight o'clock, dark and gloomy, without
“ any particular appearance ; the air was quite calm, and mild.
“ When I got up in the morning, I was surprised to see the
“ country covered with snow ; the trees in the park were
“ loaded with it ; I believe no morning in the last winter
“ could have presented more appearance of extreme severe
“ weather. My man slept at Nottingham ; at the house where
“ he was, the earthquake was so violent as to cause the cham-
“ ber bells to ring. I inquired of two soldiers belonging to
“ the barracks, situated on the high ground in the park near
“ that town, what was felt of the earthquake there. They
“ told me the shocks were very strong, so much so as to alarm
“ them greatly, and to shake the plates off the shelves. I
“ farther inquired whether any blaze of light, or ball of fire,
“ was seen when they first heard the blast, or during the
“ shocks of the earthquake. They said, that no light was seen
“ at either of these periods, nor did the centinel on guard per-
“ ceive any singular appearance whatever.

“ Here, in the vale of Belvoir, most people were in bed, and
“ were awakened by the shocks, which they describe to me, as
“ raising up the bed, and then shaking it ; so that at first they
“ thought somebody had hid themselves under the bed, and
“ was playing tricks to frighten them ; but, when they heard
“ the doors rattle violently, the plates on the shelves move,
“ glass, china, &c. jar together, they were aware that the cause
“ of all this was an earthquake. Very few were awakened by
“ the blast, and none I have conversed with saw any meteor,
“ or other appearance of light. The shock was so strong at
“ Colston Basset (two miles from Langar) as to shake a small
“ dog off the bed on which it slept. Bricks, such as were

“ most likely ready to fall by the first gust of wind, were shaken
“ off the chimnies. Some small part of the bank of the canal
“ near Redmile was thrown back again into the canal; which
“ is supposed to have been done by the earthquake, the bank
“ having been in an uninjured state the preceding evening.
“ Concerning the direction of the shocks, people here do not
“ accord; this is not to be wondered at, as most of them were
“ awakened out of their sleep, and could not collect their
“ thoughts together soon enough to ascertain this circum-
“ stance. In general, those who were awake, previous to the
“ shocks, seem confident they came from the north-east, but
“ many think they came from the south. The first shock felt
“ to me so tremulous that I could not form any judgment con-
“ cerning its direction; my chair was shaken with a kind of
“ vertiginous motion. The second shock seemed to come
“ from the north, perhaps a few points to the west of it.

“ When I heard the blast burst out, and rush on, with a
“ whizzing noise, through the air, I immediately concluded
“ that some electric meteor (which, I supposed, took fire
“ at that time) was the cause which produced that alarming
“ dismal sound which we heard; and that the concussion in
“ the atmosphere, being communicated to the earth, had
“ shaken it with such forcible agitations as to cause the
“ shocks of the earthquake. The clouds on the preceding
“ evening, being to all appearance very highly charged with
“ electric fire, confirmed me in this opinion; yet, as far as
“ I can ascertain, and I have diligently inquired of various
“ persons who were out, and in situations where they had
“ a considerable extent of view, no meteor, nor light what-
“ ever, was seen hereabouts at any time that night. Those

“ in bed (as I have already related) felt themselves lifted up,
“ and shaken. From this circumstance, one is led to imagine
“ the cause of the earthquake to have been within the earth ;
“ yet, all the circumstances considered, I incline to think some
“ violent concussion in the air occasioned it. The blast
“ (whatever was the cause of it) was undoubtedly in the
“ air. The very heavy fall of snow during the night seems a
“ singular circumstance ; it might be accidental, yet I feel a
“ bias to think it so far connected with the cause of the earth-
“ quake, as to have been the result of a sudden and extraor-
“ dinary change in the atmosphere, brought about by some
“ electric agency ; and that it was a collateral effect of the
“ cause (be that cause what it may) which occasioned the
“ earthquake.

“ I have been, since the earthquake, on the eastern side of
“ Derbyshire ; it was felt there very smartly. I remark that
“ most places in high situations were shaken with more vio-
“ lence than those in flat countries ; for instance, in Derby-
“ shire ; at the barracks near Nottingham ; and in the villages
“ which, in the south direction, bound this vale.”

The other account from Nottinghamshire is given by Dr.
STORER, in the following letter, dated Nottingham, March 12,
1796.

“ On the 18th of November last, at eleven o'clock at night, a
“ very smart shock of an earthquake was felt in this town and
“ neighbourhood. It was preceded by a noise, which appeared
“ to me like that of dancing in the room over that in which
“ I sat, accompanied by a clattering of the furniture ; and
“ beginning, as seemed to me, at the north-east, and passing
“ to the south-west corner of the room. To others the reverse

“ of this appeared to be the direction ; but all who attended
“ to the circumstance of direction, attribute to it a southerly
“ and northerly course ; and every person, whether within or
“ out of doors, referred the noise to something above their
“ own situation. I think the noise continued about three
“ seconds, and was instantly succeeded by the shock ; which
“ was so considerable and alarming as to give me the idea of
“ an earthquake, from the moment of its commencement, and
“ to make me imagine that I saw, as well as felt, an elevation
“ of the hearth, on which my feet rested as I sat ; but which
“ was not found to be displaced, in respect to surrounding ob-
“ jects. That the walls of the room suffered a considerable con-
“ cussion was evident, from the vibration of the window-shut-
“ ters, pictures, and every other pendulous object in the room.

“ I had guessed the duration of the shock itself to be four
“ seconds ; but a friend of mine (who had experienced similar
“ shocks in Carolina) assured me that, after the first impulse,
“ he had time to look at his watch, and to count four seconds
“ before its termination : in his opinion, the duration of the
“ shock could not be less than five seconds and a half. Such
“ was the violence of it, that (though no material damage hap-
“ pened to the buildings) most people in this town and neigh-
“ bourhood, who were asleep, were awaked ; and many so
“ suddenly and completely as to be conscious of having expe-
“ rienced an earthquake.

“ Nothing connected with this object has surprised me so
“ much as the extreme disparity of the sensations communi-
“ cated by the shock to different people, in the same room,
“ and in all respects similarly circumstanced. Every person

“equally heard the noise, and had their attention awakened
“by it; yet some felt the shock in an alarming degree, while
“others, at the distance of a few yards, perceived nothing but
“the noise, and the rattling of the furniture; a few felt some-
“thing like an electrical shock, and nothing else.

“Though there are many mill-ponds, canal reservoirs, and
“other considerable pieces of water, in this county, which
“would have been liable to untoward accidents from any ma-
“terial agitation or elevation of their surfaces, I do not find
“that any such thing was observed.

“As it is unusual for workmen to be in the coal mines at
“that hour of the night, I have heard of but one instance
“where that was the case. In one of the mines there were a
“man and a boy; the former felt nothing; the boy, who was
“nearer the shaft, perceived a rumbling, which he supposed
“to be at the top of the shaft, but felt no shock.

“I have seen few people here who were in the streets, or
“without doors, at the moment the earthquake happened,
“and of these no one perceived any light in the heavens; but
“it is reported that a light was seen by the passengers in
“some of the coaches; and a very intelligent gentleman of
“Derby told me that, being in the street, he perceived, at
“the instant of the concussion, a remarkable coruscation,
“proceeding from the south-west quarter of the heavens,
“ (which he could not then see,) and producing a gleam simi-
“lar to a distant flash of lightning, but of longer continuance.
“Others, at Derby, saw the same thing through their win-
“dows.

“In every direction, to the distance of 25 miles at least

“ from this place, the shock was felt with equal force ; beyond that distance, my information is too inaccurate to be stated here.

“ The state of the atmosphere that accompanied this phenomenon is scarcely less remarkable than the earthquake itself. In the night of the 17th it had blown with some violence from the south-west ; in the morning the gale increased, and at eleven o’clock blew a tempest, accompanied with very dark dense clouds, and with a greater degree of warmth, or rather sultriness, than I ever recollect to have felt in November, when there was no sunshine. About mid-day there fell a heavy rain, for an hour ; after which the wind abated, the clouds dispersed, and at six o’clock it was a serene calm evening. At the moment of the earthquake it was perfectly still, and continued so at one o’clock in the morning, with the same degree of warmth that had prevailed in the day. At eight o’clock the following morning it froze intensely, and the ground was covered with snow.

“ It being very generally agreed to refer the most formidable earthquakes to subterraneous causes, it may be thought unphilosophical to search for causes of a different order from those that are known to produce similar effects ; yet it must be admitted, that many circumstances in the preceding account conspire to connect the concussion with the very singular state of the atmosphere accompanying it, and irresistibly to direct our inquiries to those sudden revolutions to which so vast a mass of elastic and heterogeneous fluid is liable.”

Having now laid before the Society all the circumstances observed in the late earthquake that appear to me to be wor-

thy of their attention, I shall proceed to make a few observations upon them; and particularly to examine how far it is possible, by tracing the direction of the earthquake, to determine whether it was produced by a central force acting in all directions, or whether, like a blast of wind, it had a progressive motion one way only.

And first I must observe, that all ideas of its direction, founded on the sensations of those who felt it, are so vague and contradictory as to render it impossible to draw any conclusion from them. Mr. GREGORY, who in his letter says the blast came from the west, says also, that people in general seem confident that the shocks came from the north-east, but that many think they came from the south; and that, to himself, the second shock appeared to come from the north. Dr. STORER says the direction appeared to him to be from the north-east to the south-west, but to others it appeared the reverse. The accounts of the earthquake's direction in the county newspapers are as various as the above; but I think it needless to give any farther proofs of what I have advanced, and shall only observe that, various as the opinions of those who felt the earthquake were, with respect to its direction, the greater number of persons agreed in thinking it to have been from some northern point towards a southern one; which, as we shall presently see, is as contrary as possible to that direction which is deduced from observations of the time at which it was felt in different places.

In the county papers, the earthquake is said to have been felt at Bristol, and in some parts of Gloucestershire, some minutes before eleven. At Worcester, it is said (by Dr. JOHNSTONE) to have been felt about eleven, or five minutes after.

At Kenilworth, in Warwickshire, (Mr. JOHNSON,) six minutes after eleven. At Ashover, in Derbyshire, (Mr. MILNES,) 'about a quarter past eleven. At Wirksworth, in the same county, (Mr. BENNET,) about twenty minutes past eleven. And at Wollaton, in Nottinghamshire, (Mr. GREGORY,) between twenty and twenty-five minutes past eleven.* From this, about five minutes and a half are to be deducted, for the difference of longitude between Bristol and Wollaton. Great allowance must likewise be made for the uncertainties which attend observations of this kind, from the different manner of keeping clocks, and from other circumstances too obvious to be mentioned; but it must be remembered, that those circumstances are as likely to occasion error on one side as on the other; and, when the whole is fairly considered, it seems to me impossible not to feel inclined to think that the earthquake was felt considerably later in the north-east than in the south-west; in other words, that it moved progressively from the south-west to the north-east, or nearly so.

Supposing, however, that some of the abovementioned observations of time are of too uncertain a nature to admit any inference to be drawn from them, others among them are of a very different kind. Mr. JOHNSON, whose accuracy may be safely relied on, appears to have remarked the time of the earthquake with great precision, and he states it to have been, at Kenilworth, at six minutes past eleven. Mr. GREGORY, to whose exactness we may equally trust, says the blast was heard, at Wollaton, between twenty and twenty-five minutes

* I have omitted mentioning the time expressed in one or two of the foregoing letters, because it appears not to have been observed with much attention.

past eleven, and the earthquake came on about a minute after the blast. Now, if we suppose it to have been only twenty-one minutes past eleven when the blast was heard, it will bring the time of the earthquake to twenty-two minutes past eleven; and, if we allow a minute and a half for the difference of longitude between Kenilworth and Wollaton, there will still remain an interval of fourteen minutes and a half for its progress from the first mentioned place to the latter. The distance between these two places is about forty-five miles, and the situation of Wollaton, with respect to Kenilworth, is about north north-east: consequently, the observations of Mr. JOHNSON and Mr. GREGORY are, of themselves, sufficient to render it probable (as far as observations of time made in two places only can do so) that the direction of the earthquake was not very different from that above stated; at least, that it was from some point to the westward of south, towards some point to the eastward of north; which, as was before observed, is very contrary to the idea which most persons who felt it formed of its progress.

These two observations also, in my opinion, furnish another argument that the earthquake moved progressively in one direction only; for, if it had been produced by a central force acting in all directions, we should surely have expected that the effects of that force would have been most powerful where they were first felt; whereas, we have seen that the earthquake, though undoubtedly more severe in Nottinghamshire than in Warwickshire, was felt much sooner in the last mentioned county.

Of the various earthquakes felt in England within this century, those to which the one here treated of has most analogy

are, that of September 30, 1750;* that of September 14, 1777;† and that of February 25, 1792.‡ The earthquake of last year was of much greater extent than either of the others, consequently a much greater number of counties came within its influence; but there is, to a certain degree, a general analogy in the tract of country affected. It is also observable, that the direction assigned to the abovementioned three former earthquakes, is nearly the same as that I have supposed to have been the direction of the one here described.§ This recurrence of earthquakes, in former tracts, has been long observed in all countries much subject to them; and has, with great reason, been considered as a strong argument in support of the opinion, that their cause is situated within the earth.

It has also been observed in many earthquakes, as in this, that, whatever was the state of the wind some time before, it was calm at the instant the earthquake happened. This has indeed been so generally the case, as to have induced some to suppose that wind would prevent a certain accumulation in the atmosphere, which, according to their theory, is necessary for the production of an earthquake.|| Unfortunately for that theory, however, there are more instances than one of earthquakes having happened during a gale of wind.¶

* Described in the Philosophical Transactions, Vol. XLVI. page 701, *et seq.*

† Described in the Phil. Trans. Vol. LXVIII. page 221.

‡ Described in the Phil. Trans. for the year 1792, page 283.

§ See Phil. Trans. Vol. XLVI. page 722; Vol. LXVIII. page 227; and that for the year 1792, page 287.

|| See Phil. Trans. Vol. XLVI. page 676.

¶ Dr. THOMAS HEBERDEN, in his account of an earthquake felt in the island of Madeira, March 31, 1761, says, “ though it has been remarked that a calm always

Some persons thought this earthquake was most severely felt in high situations ; others remarked that some low places were just as much affected : upon the whole, there does not seem room for any material inference on this head.

That the waters about Nottingham should not, according to Dr. STORER's observation, have suffered any remarkable agitation or elevation, may be thought surprising ; especially when it is recollected that the earthquake of November 1, 1755, which was so fatal to the city of Lisbon, occasioned an unusual agitation of the waters in various parts of this kingdom, without occasioning any perceptible motion of the earth in those parts.* A similar circumstance, however, is recorded by M. BERTRAND, respecting an earthquake which was very severe in many parts of Switzerland, on December 9, 1755, but which, as he says, produced little or no agitation of the lakes there ; whereas a very considerable one had been produced in them by the earthquake of November 1, in the same year, though it was but slightly felt upon the earth.†

“ attends an earthquake, no such thing happened now ; a fine gale of wind blowing “ before and after, as well as during the time of, the shock.” (See Phil. Trans. Vol. LII. page 156.) M. BERTRAND also, speaking of an earthquake felt at Zurich, December 9, 1755, says, “ Le tremblement étoit accompagné d'un vent violent, que quelques “ personnes ont apperçu dès le commencement, d'autres à la fin des ébranlemens.” See *Recueil de divers Traités sur l'Histoire Naturelle de la Terre*, par M. E. BERTRAND, page 289.

* See Phil. Trans. Vol. XLIX. page 351, *et seq.*

† Of so remarkable a circumstance, it may not be amiss to give M. BERTRAND's account in his own words : “ A Vevey, les rues le long du lac ont été plus agitées ; les “ cloches ont donné du son ; quelques vases ont été renversés ; des portes ont été “ ouvertes ; des tuiles sont tombées des toits, &c.—Ni à Vevey, ni ailleurs, sur les “ bords du lac Lemman, on n'a apperçu aucune hausse de ses eaux. Il est bien re- “ marquable que les lacs de la Suisse aient été plus émus du tremblement de terre du

The wind felt in the mine at Ashover, was probably the effect of the blast mentioned by Mr. GREGORY. Similar blasts have been taken notice of in many other earthquakes; a rushing wind is said to have accompanied that felt in England, September 14, 1777.*

With respect to the other unusual atmospherical circumstances with which this earthquake was accompanied, I shall only observe, that similar ones, particularly black dense clouds, coruscations in the air, &c. have been noticed in several other earthquakes; yet, upon the whole, perhaps few have been attended with more remarkable circumstances of that kind. How far they were connected with the earthquake, it is impossible to determine; be that as it may, it must be allowed that they appeared to be so, to such a degree as very naturally to incline those who noticed them to be of opinion, that the cause of the earthquake was situated in the atmosphere. Upon this head I cannot help remarking, that those who entertain that opinion respecting the cause of earthquakes, seem always to conclude that the electric fluid must, in that case, necessarily be the agent. This, I think, is going too far: we surely do not know enough of the nature of the atmosphere to warrant us in making such a conclusion; and what we do know of electricity (either natural or artificial) rather leads us to conceive that the electric fluid is formidable only when concentrated, or collected within a certain space, and moving with

“ premier Novembre, que de celui du neuvième Decembre; quoique le premier ne se
“ soit fait sentir dans les terres que légèrement, et dans un petit nombre d’endroits;
“ au lieu que le dernier a secoué tout le terrain, sans emouvoir les eaux. Pourquoi
“ cette différence dans les effets?” BERTRAND, *Recueil de divers Traités, &c.* page
283.

* See Phil. Trans. Vol. LXVIII. p. 227.

infinite velocity; consequently its effects are limited in their extent, and it is instantaneous in its operation. Whereas earthquakes have, more than once, extended their effects over immense portions of the globe; and they appear to move (sometimes at least) with a degree of slowness of which we cannot suppose the electric fluid capable, without supposing it thereby so far divested of its destructive power, as to be incapable of producing what is truly considered as the most dreadful of all natural phenomena.*

The foregoing reflections are offered as naturally arising from the consideration of the account here given, and by no means as taking either side of the great question, whether earthquakes are to be considered as terrestrial or as aerial phenomena. A question which appears to me to be involved in the greatest obscurity; and this obscurity seems to arise, not so much from a want of arguments on either side, as from the arguments on both sides being so many, and so strong, that the mind hesitates less which side to choose, than which to reject. For as, on the one hand, there are many circumstances attending on earthquakes, (particularly their frequent recurrence, in many parts of the world, in the same tract,) on which it is impossible to reflect, and not feel disposed to believe their cause situated in the earth; so, on the other hand, it seems equally impossible to reflect on the unusual atmo-

* Of the slowness here spoken of, the earthquake described in the foregoing pages affords sufficient example, particularly in its progress from Kenilworth to Wollaton; (see page 374;) but, in the account of an earthquake felt near Oxford, June 19, 1665, it is said, that “Dr. HOLDER, F.R.S. who was then at Blechington, took notice that it “was observed by those in the further part of the garden, some very discernible time “before it was observed by those in the house, creeping forward from the one place to “the other.” See *Phil. Trans.* Vol. I. page 169.

spherical appearances, with which the earthquake here described and many others have been accompanied, and suppose all those appearances merely accidental, and unconnected with the earthquakes. It is not, however, my intention to enter into a minute examination of this part of the subject; but I cannot refrain from hinting, that those who may hereafter be inclined to do so would perhaps do right to begin by inquiring, whether all commotions of the earth which go under the name of earthquakes are really produced by the same cause.* After that, as a subject so full of difficulties ought to be viewed in every possible light, it might not be amiss to consider whether, supposing the cause of an earthquake situated in the earth, that cause may not be capable of affecting the atmosphere, in such a manner as to occasion those appearances in it which we find so difficult to explain; or whether, if the cause be supposed to be seated in the atmosphere, certain tracts of country may not (from some circumstances with which we are unacquainted) possess a peculiar disposition to bring that cause into action, by co-operating with it.

* To prove that this is not an unnecessary inquiry, it might perhaps be sufficient to refer to what has been said respecting the agitation of the waters; (page 376;) but, as a farther proof that earthquakes either differ from each other, or appear to do so to different persons, I may add, that though I have endeavoured to show that the slowness with which earthquakes sometimes move is a strong argument against their being caused by electricity, yet Dr. STUKELEY, the first promulgator of the electric theory, as one of his arguments in its favour, says that, as far as he could learn, the earthquake of September 30, 1750, was felt over its whole extent precisely at the same instant. (See Phil. Trans. Vol. XLVI. page 738.) BECCARIA also, whose theory is an electric one, (though very different from Dr. STUKELEY's, inasmuch as he considers the electric fluid within the earth to be the chief agent,) lays great stress, in support of his theory, upon the velocity with which, as he says, earthquakes move. See *Beccaria, dell' Elettricismo artificiale e naturale*. Cap. vii. § 679.

I have ventured to propose the consideration of these mixed causes,* if I may so term them, because I think it very certain that none of the theories hitherto formed respecting earthquakes, are by any means adequate to explain their various phænomena. I leave it to future theorists, should any adopt the principle, to determine which of the elements is concerned in a primary, and which in a secondary way; also what share in the attendant phænomena is to be assigned to each element.

In whatever light the subject is viewed it seems to present so many difficulties, that perhaps the best we can do is, to consider our knowledge respecting earthquakes as consisting merely in a certain number of facts, to which many more must probably be added, before we shall be able to understand the cause of a phænomenon whose dreadful effects have, in all ages, been too well known in every quarter of the world. So frequent indeed are earthquakes in some parts, that it is impossible, without being fully sensible of our happiness, to reflect

* Dr. HALE'S theory of earthquakes was founded upon a sort of mixed cause: he supposed sulphureous vapours to arise from the earth, and to form clouds, the explosive lightning of which kindled the ascending vapours in the earth, and thereby caused what he calls an *earth lightning*; which lightning he considered as the immediate cause of earthquakes. Yet, so imperfect was the aerial chemistry of those days, that the experiment by which he illustrates the operation of his sulphureous vapours, consists only in mixing together nitrous gas and common air, to show the red fumes, and diminution of bulk produced. (See Phil. Trans. Vol. XLVI. page 672 and 677.) If Dr. HALE had been acquainted with modern chemistry, he would undoubtedly, I think, have made inflammable gas the basis of his theory; and indeed, when it is considered that there are great quantities of this gas in the earth, that it readily ascends into the atmosphere, and that, when inflamed, it is capable of producing the most violent effects, it appears to me that it has at least as much claim as the electric fluid, to be reckoned among the probable agents in earthquakes.

on their comparative infrequency here ; which is such as to give us every reason to hope, that (whatever philosophy might gain by the extension of our knowledge on so interesting a subject) the island we inhabit will contribute but a small share of those materials which are still wanting to form a complete theory of earthquakes.